Blooms of cyanobacteria

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Cyanobacteria exist worldwide ubiquitously, including extreme environments. Some of these cyanobacterial species produce complex compounds (sec. metabolites) at great energy expense. The ecological or physiological function or advantage of these compounds for these cyanobacteria species is yet unknown. Most of these metabolites are very small alkaloids or peptides, with a molecular weight of <2kD, a very complex structure and, in case of the peptides, composed of uncommon amino acids. Amongst the alkaloids synthesized by cyanobacteria are e.g. saxitoxins or anatoxins, known to be toxic for humans and other organisms already at very low concentrations. The cyanobacterial peptides are not metabolized in the mammalian digestive tract due to the presence of D-amino acids and cyclic structure. Consequently, either local toxicity, e.g. diarrhoea, or systemic toxicity, e.g. hepatotoxicity, neurotoxicity, renal toxicity i.e. morbidity or even mortality are the direct consequences of acute exposure. However, the uptake of these toxins and organ distribution appears to be mediated by specific transporters, of which most if not all remain unidentified in the human and other mammalian species to date. In order to provide for a reasonable hazard and risk assessment of these toxins in conjunction with an acute or chronic exposure, it is prerequisite to characterize the uptake and distribution (kinetics) and consequently the toxic dose that induces *in-situ* effects (dynamics) of these toxins. Moreover, it is essential to understand the kinetics and dynamics and thus the hazard and risk of single toxins before the hazard and risk of toxin mixtures can be evaluated and meaningful risk management strategies can be developed. However, in the environmental setting, not every cyanobacterial family or even strain within a family synthesizes highly toxic alkaloids and peptides, meaning that the simple occurrence of cyanobacteria in a water body does not mandate the presence of cyanobacterial toxins. In order to ensure that the respective water body is free of or has only a limited contamination with toxins, specific toxin analyses should be carried out. However, to do this on a routine basis can be financially problematic, thus calling for a prioritization of water bodies and definition of sampling routines that would ensure the highest degree of safety at reasonable cost. First and foremost, all water bodies in use as drinking water resources must be controlled routinely, the frequency of analyses depending on the cyanobacterial history of the water body and the observation of the water body by qualified personal. However, even oligotrophic lakes can contain blooms of toxic cyanobacteria that are not readily and routinely observeable. Especially *Planktothrix rubescens*, having the highest microcystin concentration/cell of all known cyanobacteria occurs specially in the metalimnion of oligotrophic and deep lakes, sometimes even during winter. Second, water bodies used for aquaculture (fish, shrimp and shellfish) must be monitored and the products harvested must be controlled for contamination with known cyanobacterial toxins. Especially lakes in use for harvesting and the production of cyanobacterial food supplements must be controlled and a product and consumption derived limit of acceptable contamination be defined. Finally, water bodies used for recreational purposes must be monitored and the bathing areas must be closed, if the concentration of cyanobacterial toxins maybe endanger human health, especially children and toddlers.

Toxin monitoring should focus on cyanotoxins per se and not on cell densities, as density of cyanobacteria do not always correlate with the toxin concentration in the water body (extracellular toxins) and within the cell (intracellular toxins). However, meaningful monitoring, hazard and risk assessment as well as risk management demand certain prerequisites: a reliable, easy and fast detection system including a standardized sample preparation protocol, reliable standards of the known toxins, an in-depth understanding of the kinetics and dynamics of the known single toxins as well as the additive, synergistic or antagonistics effects of other toxins in the toxin mixtures within the water body and possible effects of other than the known toxins produced by cyanobacteria.